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(54) **THERMALLY SUPPRESSING CIRCUIT FOR RESTARTING A LOCKED MOTOR WITH A RESTART-DISCHARGING DRIVE MEMBER**

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(57) **ABSTRACT**

A thermally suppressing circuit mainly comprises a restart-discharging drive member, a coil set, a restart-discharging capacitor, and a discharging switch set. The restart-discharging drive member is electrically connected to the coil set and the restart-discharging capacitor while the discharging switch set connected between the coil set and the restart-discharging capacitor. The discharging switch set is used to access signals output from the restart-discharging drive member. In abnormal operation, as the restart-discharging drive member may turn on an auto-restart function to output a high or low voltage signal, the discharging switch set is turned on to accelerate discharging the restart-discharging capacitor to thereby avoid overcurrent passing the coil set.

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(51) **Int. Cl.**⁷ **H02H 5/04**

(52) **U.S. Cl.** **361/25; 361/103**

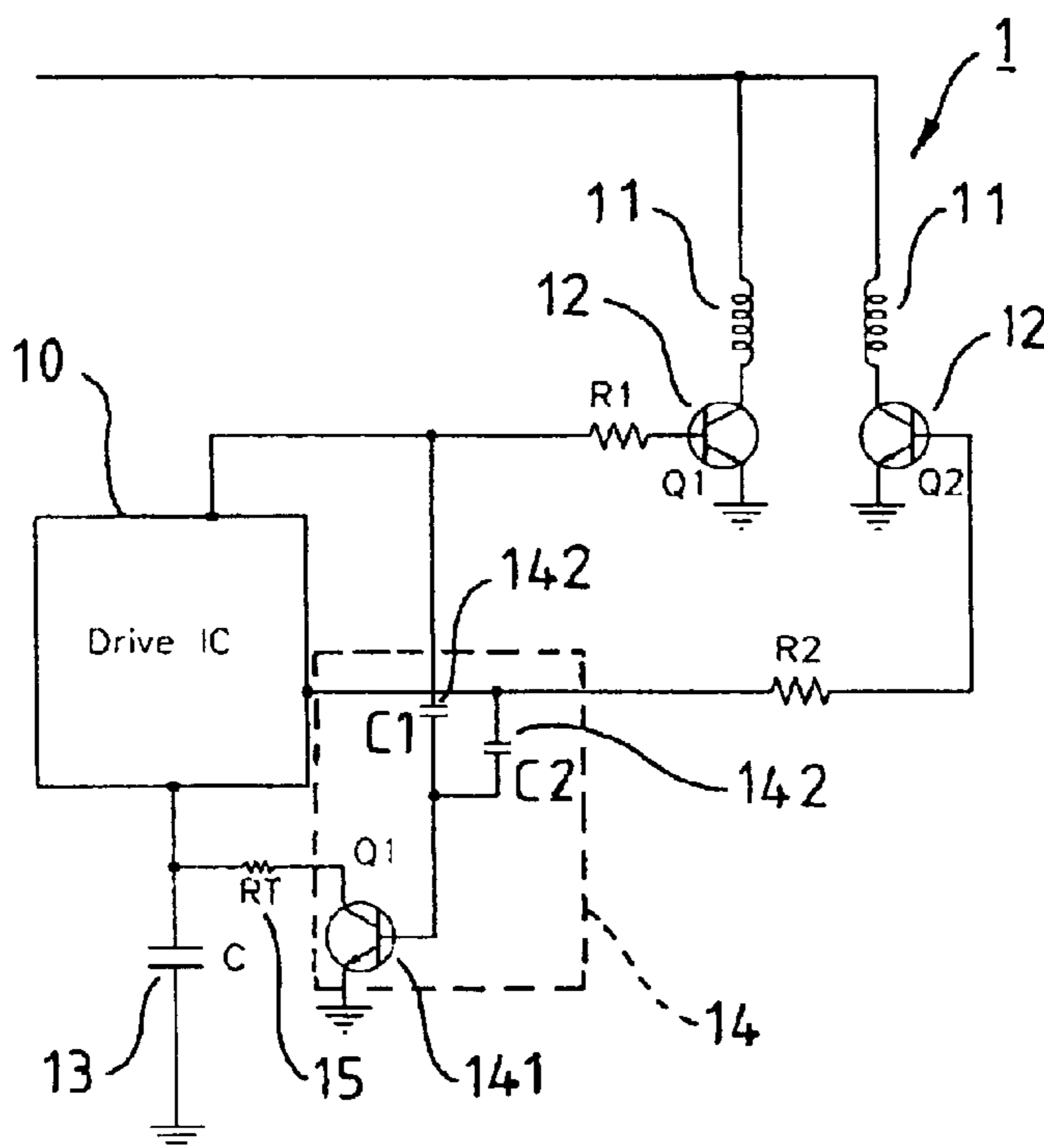
(58) **Field of Search** 361/20, 21, 22,
361/23, 24, 25, 101, 103; 318/254, 434,
459

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6 Claims, 5 Drawing Sheets



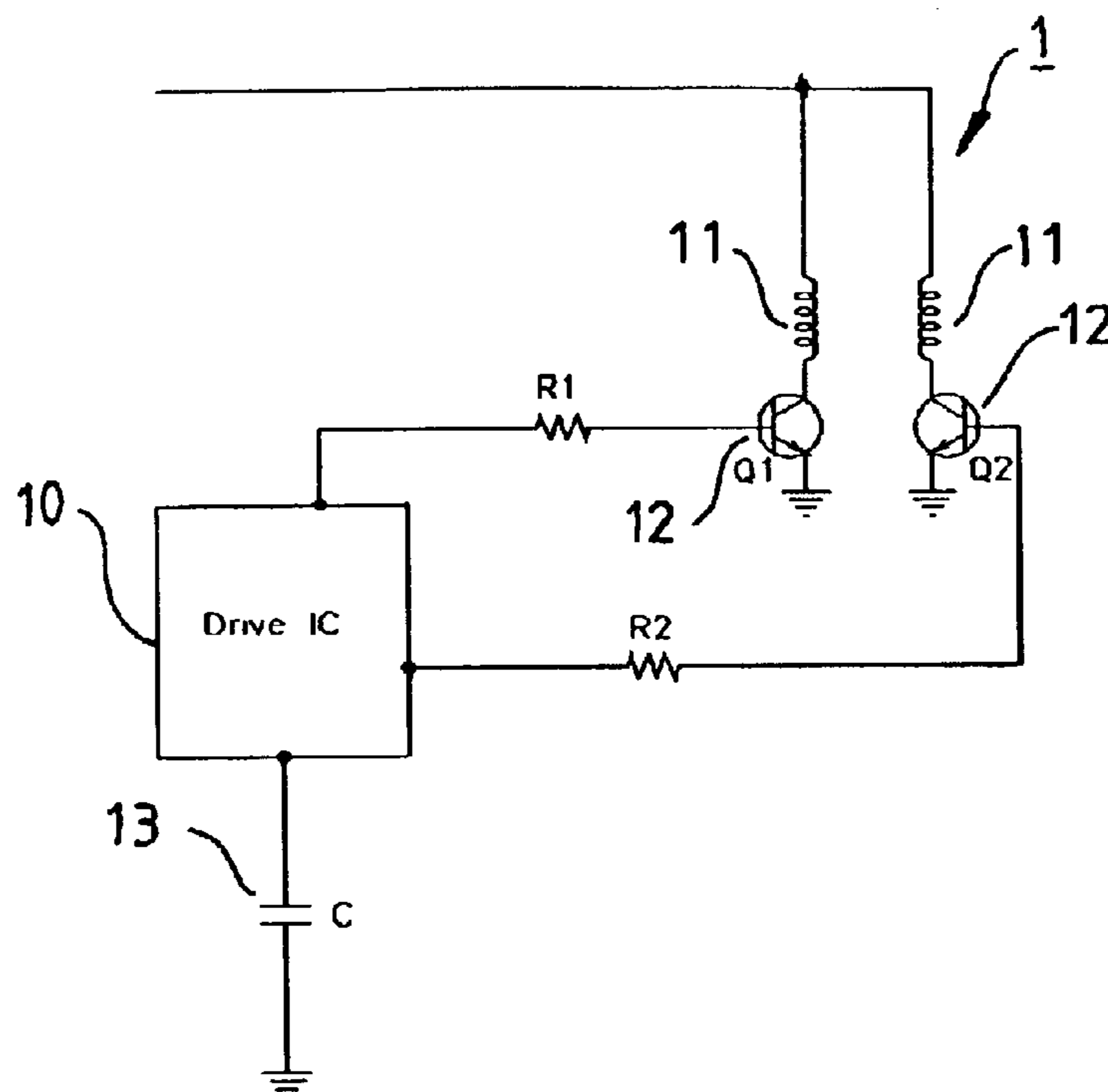


FIG. 1
PRIOR ART

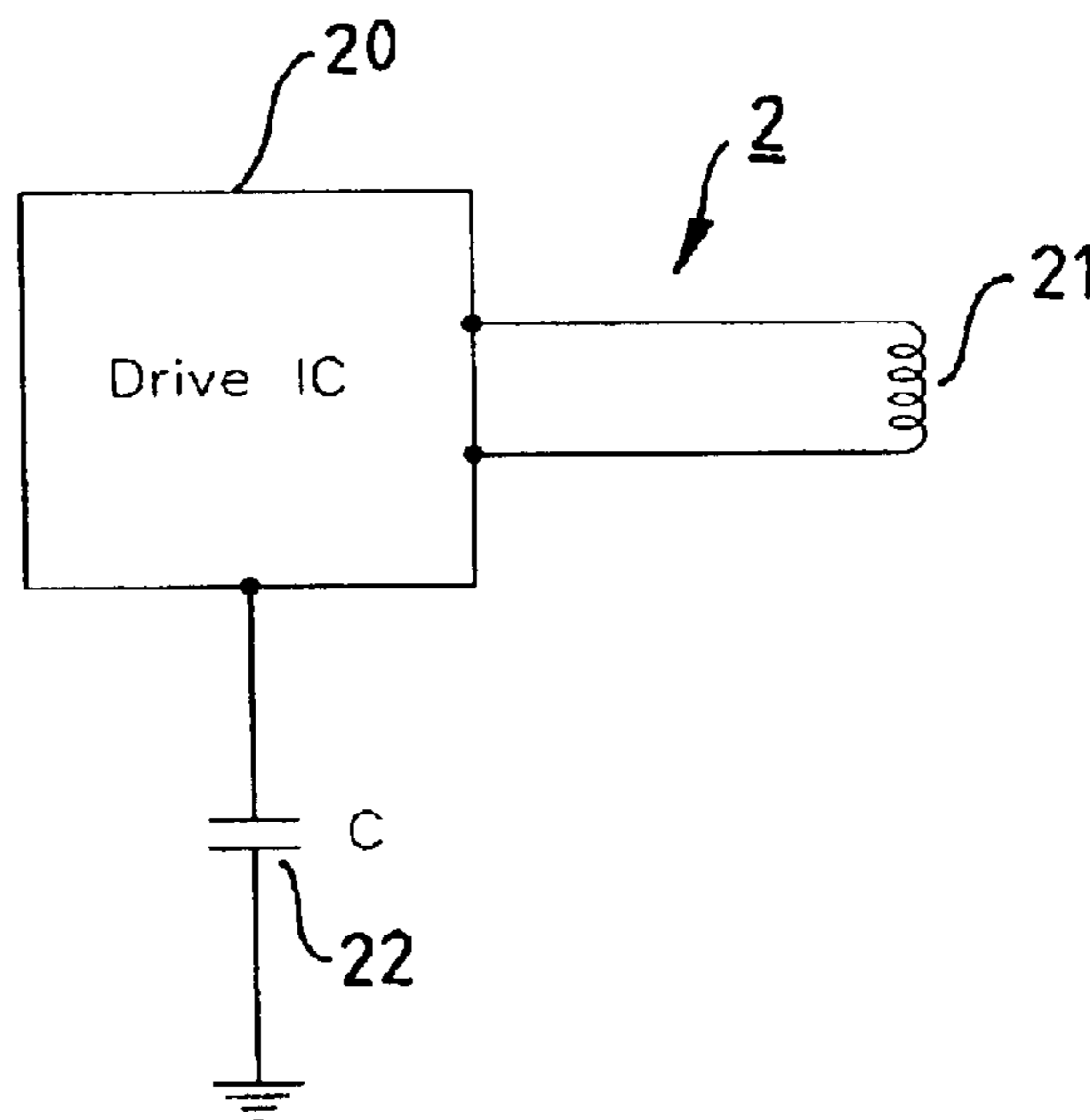


FIG. 2
PRIOR ART

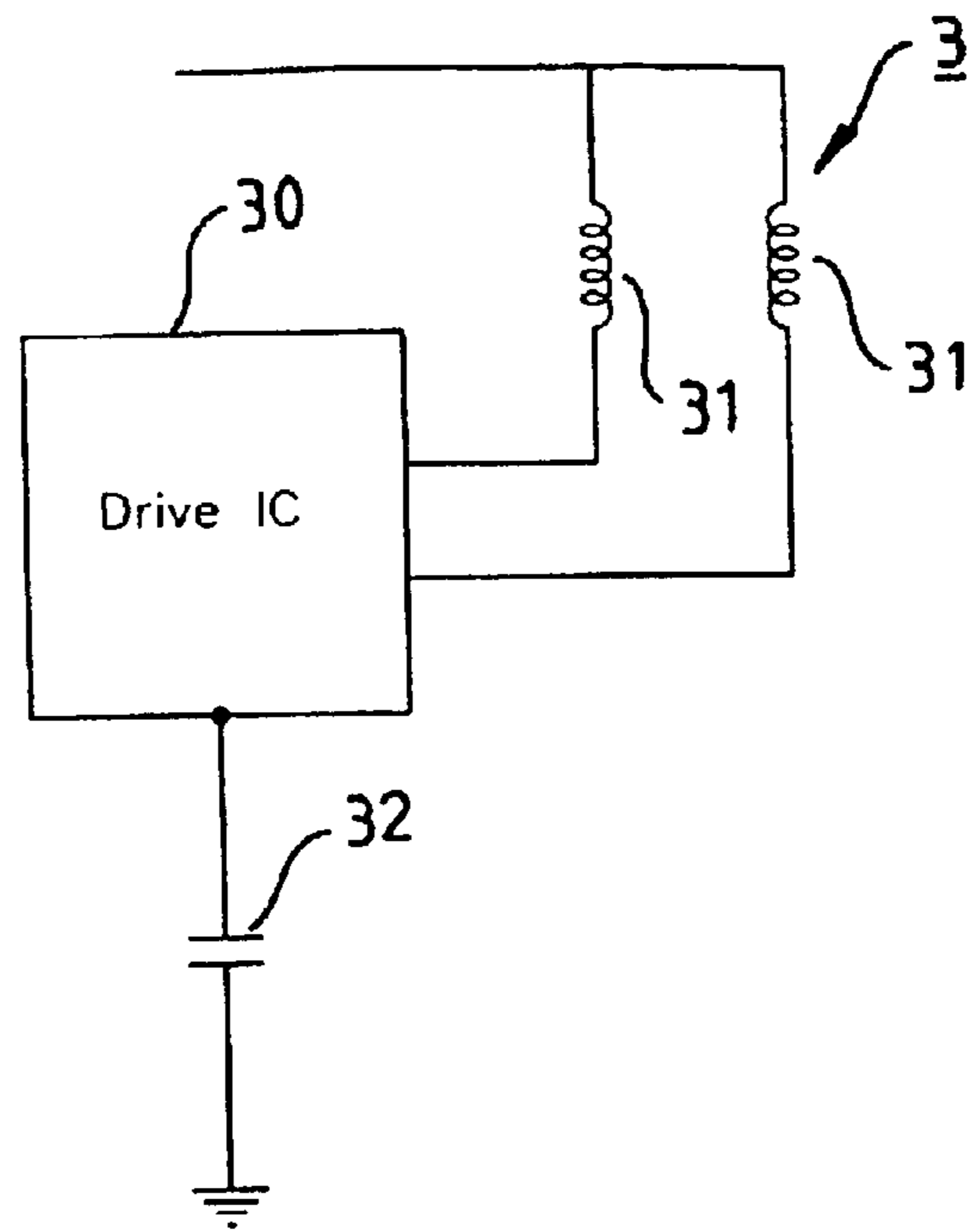


FIG. 3
PRIOR ART

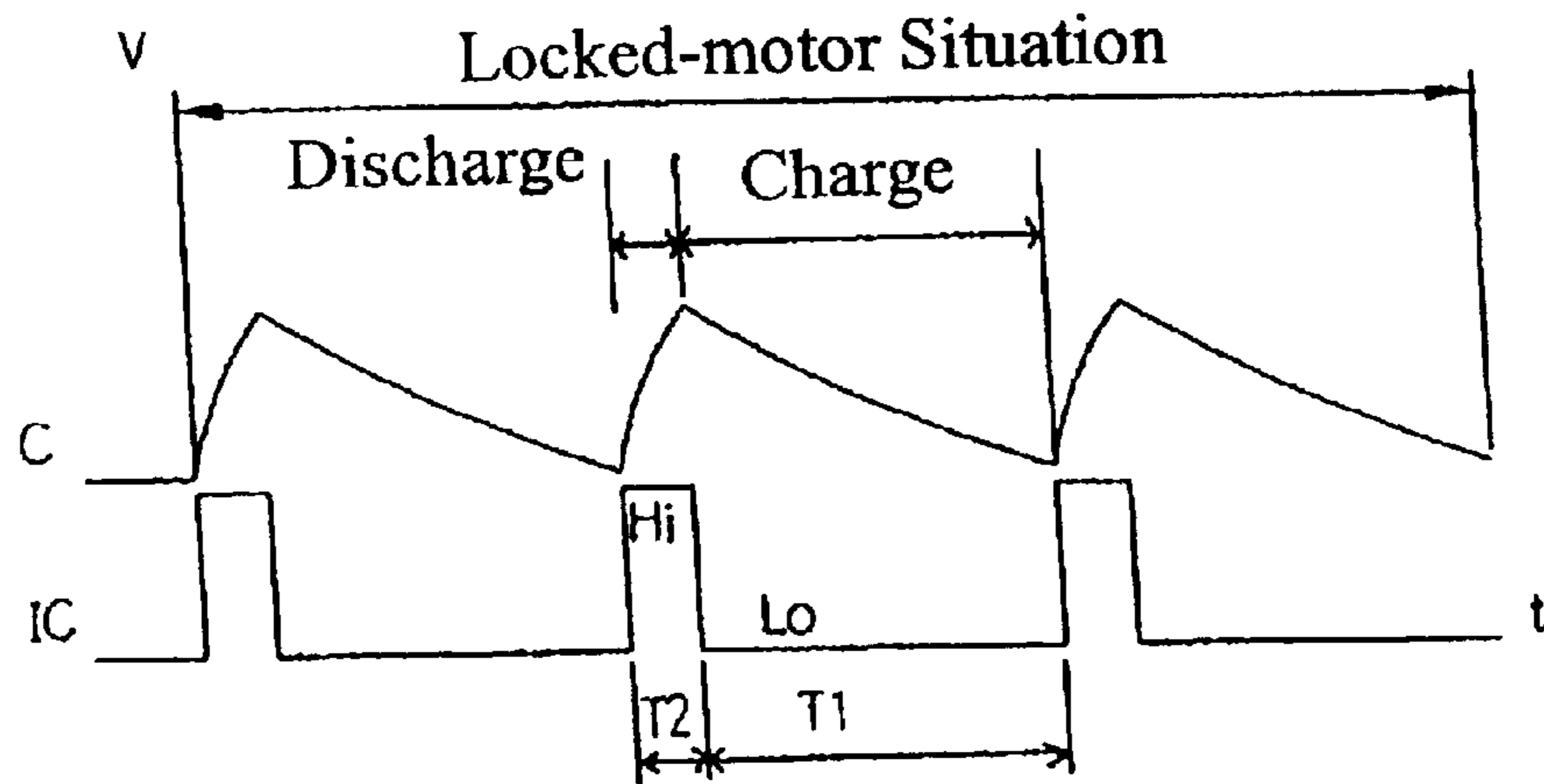


FIG. 4A
PRIOR ART

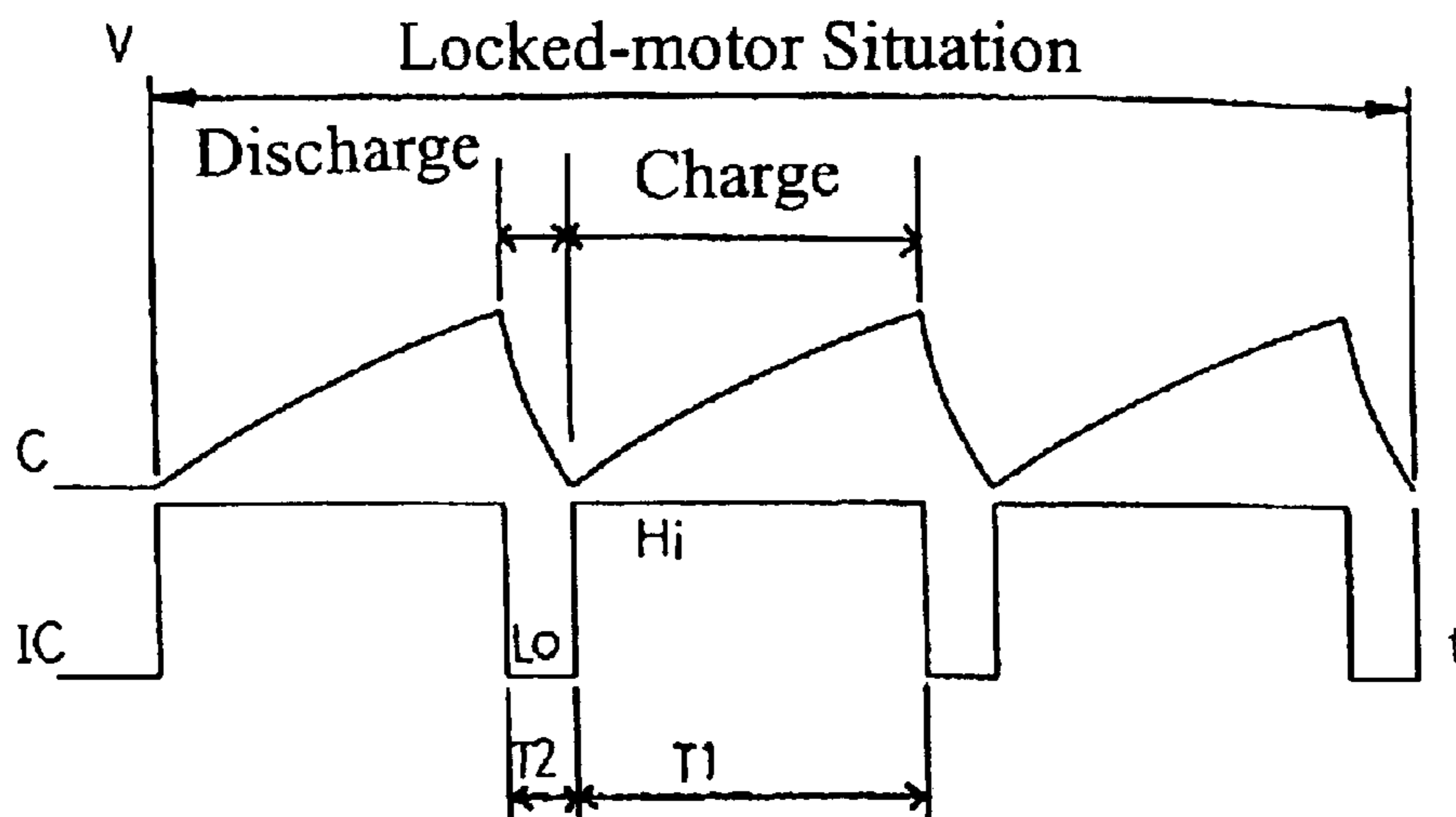


FIG. 4B
PRIOR ART

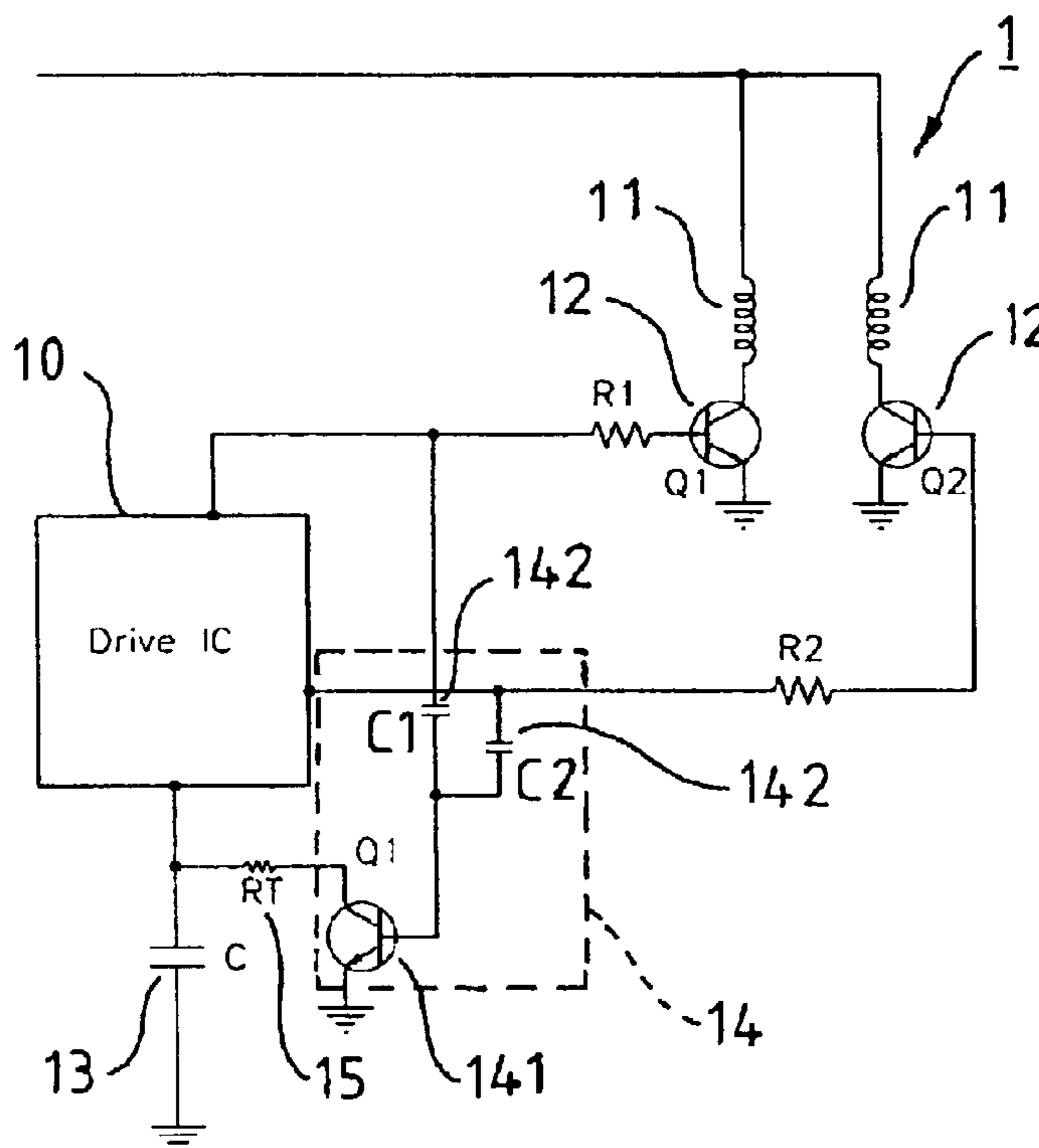


FIG. 5

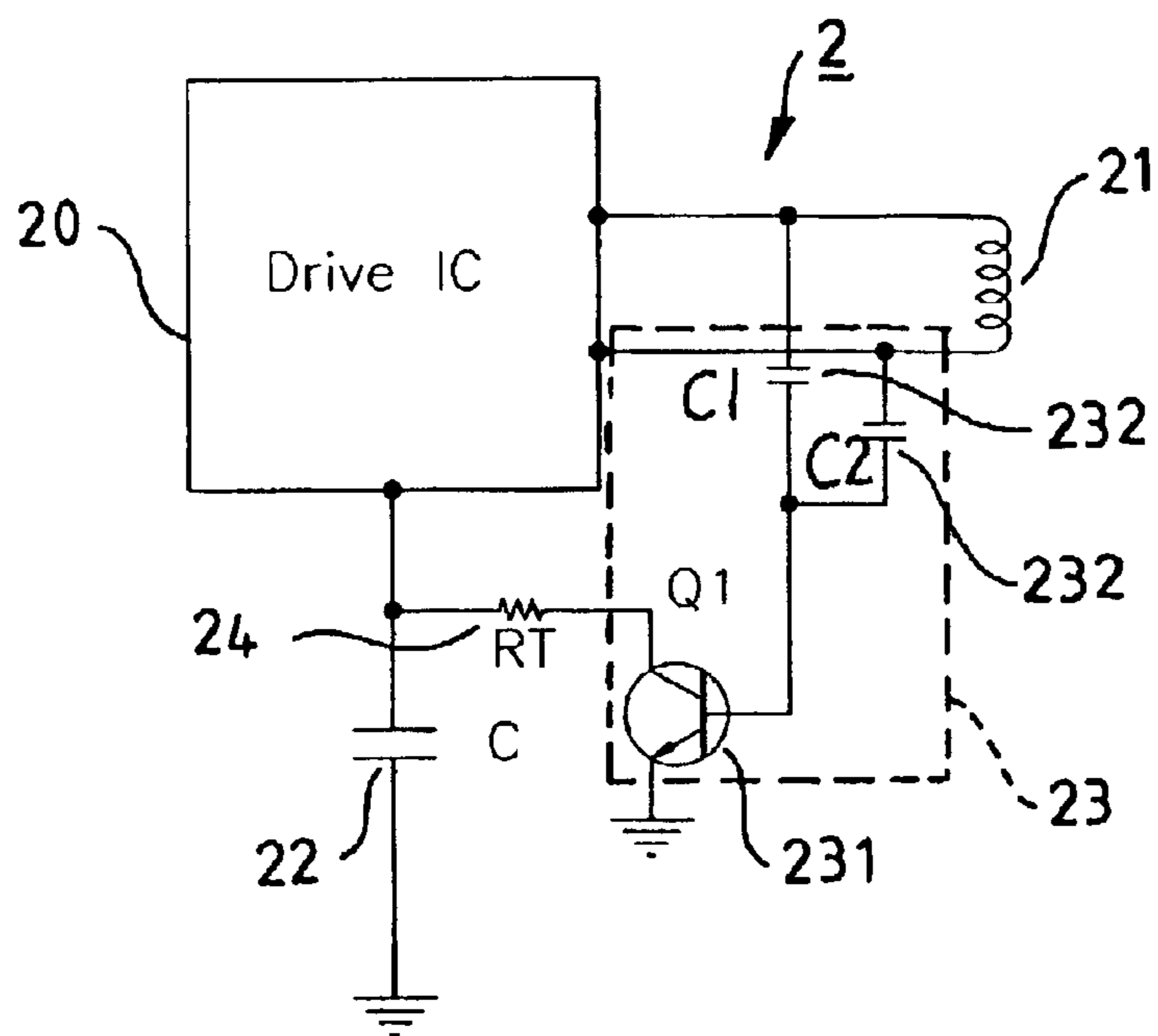


FIG. 6

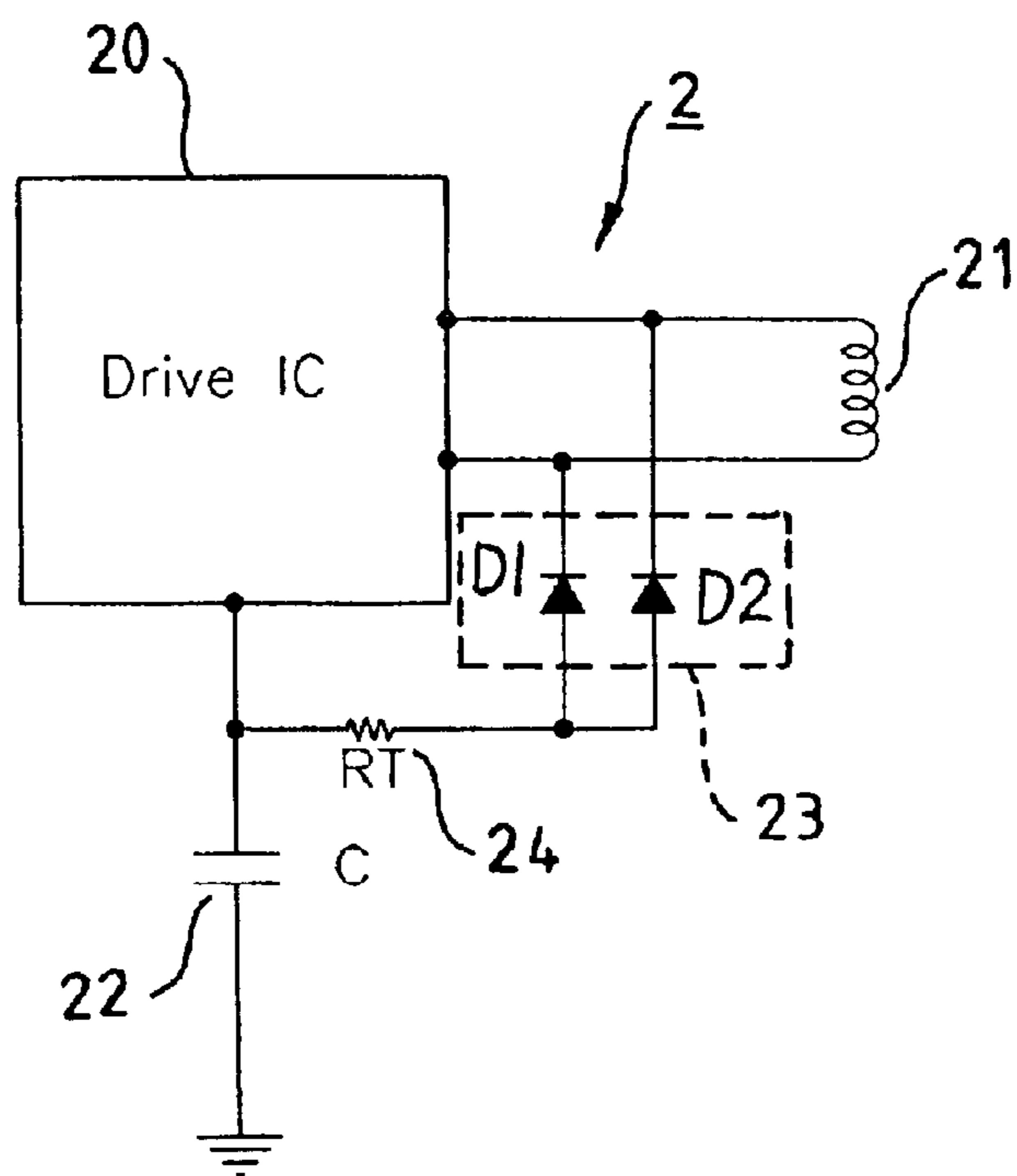


FIG. 7

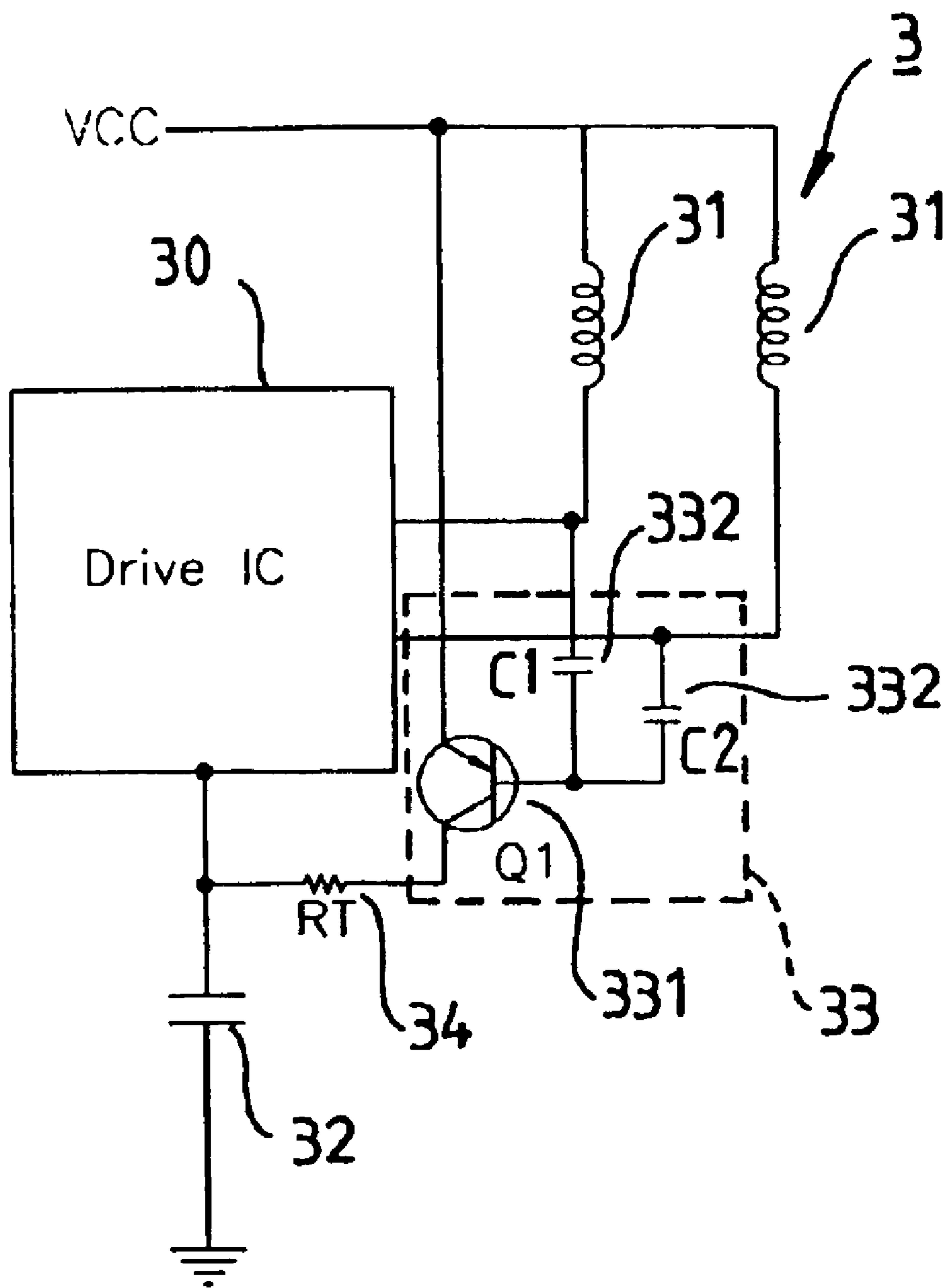


FIG. 8

THERMALLY SUPPRESSING CIRCUIT FOR RESTARTING A LOCKED MOTOR WITH A RESTART-DISCHARGING DRIVE MEMBER

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention relates to a thermally suppressing circuit, and more particularly to a thermally suppressing circuit for restarting a locked motor, which comprises an auto-restart function of a restart-discharging drive IC, adapted to reduce an auto restart time interval for a coil by means of detecting an auto restart signal to thereby avoid destroying the motor during low motor speed, locking fan wheel, or passing overcurrent.

2. Description of the Related Art

In long-term use, a conventional fan has two abnormal situations. The first situation is accumulating a huge mass of dust which results in a decrease in the motor speed. The second situation is inserting an external thing into the fan blades or the internal space of the motor which results in locking the motor. Under these two abnormal situations, the current passing the motor coil is become tremendous and increased rapid. The great power consumption, caused by the large current on the motor coil, may be changed to the heat that results in a great increase in the temperature. Also, the increasing temperature at the motor coil may further aggravate the power consumption that the temperature at the motor coil is increased repeatedly. Subsequently, the high temperature may deteriorate sharply the qualitative insulator of the enamel-insulated wire which may be cracked. Consequently, the cracked insulator of the motor coil results in a short circuit that the motor may be destroyed.

During the abnormal situation the conventional motor is designed to prevent from an overcurrent passing through the motor coil, generally an auto restart function is built in a drive IC. In this manner the restart-discharging drive IC restarts the motor repeatedly at each time interval during the abnormal situation. If the motor is broken down or fails to restart, it is initially cut off the power and then restarted at each time interval.

FIG. 1 illustrates a circuitry of a conventional double phase brushless dc motor circuit. Referring to FIG. 1, a motor drive circuit 1 comprises a restart-discharging drive IC 10, two coils 11, two transistors 12, and a restart-discharging capacitor 13. The restart-discharging drive IC 10 is adapted to turn on or off the transistors 12 to thereby control the coils 11. The auto restart function of the motor drive circuit 1 predetermines time intervals of ON and OFF whose ratio is adapted to control that of the charging time to the discharging time of the restart-discharging capacitor 13. In responding to the ON and OFF time intervals, the motor drive circuit 1 may turn on or off the transistors 12.

FIG. 2 illustrates a circuitry of a conventional single-phase brushless dc motor circuit. Referring to FIG. 2, a motor drive circuit 2 comprises a restart-discharging drive IC 20, a coil 21, and a restart-discharging capacitor 22. In responding to the ON and OFF time intervals, the motor drive circuit 2 is adapted to electrically open or close the coil 21.

FIG. 3 illustrates a circuitry of a conventional double phase brushless dc motor circuit. Referring to FIG. 3, a motor drive circuit 3 comprises a restart-discharging drive IC 30, two coils 31, and a restart-discharging capacitor 32. In responding to the ON and OFF time intervals, the motor drive circuit 3 is adapted to electrically open or close the coils 31.

FIGS. 4A and 4B illustrate waveform diagrams of a restart-discharging drive member and a restart-discharging capacitor of a brushless dc motor. Referring to FIG. 4A, during a locked situation, the restart-discharging drive IC outputs a low voltage signal (Lo) within a time interval T1 as the restart-discharging capacitor C is charged. Alternatively, it outputs a high voltage signal (Hi) within a time interval T2 as the restart-discharging capacitor C is charged to the ground in turn. Referring to FIG. 4B, during a locked situation, the restart-discharging drive IC outputs a high voltage signal (Hi) within a time interval T1 as the restart-discharging capacitor C is discharged to the ground. Alternatively, it outputs a low voltage signal (Lo) within a time interval T2 as the restart-discharging capacitor C is charged in turn.

Referring again to FIGS. 4A and 4B, the ratio of T1 to T2 is fixed and constant due to the unchangeable ratio of a charging time to a discharging time of the restart-discharging capacitor C.

Referring again to FIGS. 1 through 4A and 4B, the motor is automatically restarted by a current with maximum power consumption within a time interval T2 when the restart-discharging capacitors 13, 22, 32 are discharged to the ground. The motor is repeatedly restarted at each time interval T1 as long as the locked situation is continued. As to the low speed or low power motor, the maximum power consumption of the motor may not result in greater power consumption and a vast amount of heat. As to the high speed or high power motor, a rapid overcurrent, exceeding several amperes, may pass the coil resulting in greater power consumption and a vast amount of heat when the motor is in abnormal operation. Consequently, the motor may be destroyed due to the vast amount of heat.

The present invention intends to provide a thermally suppressing circuit adapted to reduce a discharging time interval of a restart-discharging capacitor by means of detecting an auto-restart signal for avoiding destruction of the motor in such a way to mitigate and overcome the above problem.

SUMMARY OF THE INVENTION

The primary objective of this invention is to provide a thermally suppressing circuit adapted to reduce a discharging time interval of a restart-discharging capacitor by means of detecting an auto-restart signal to thereby reduce a time interval of turning on a coil so that the motor may avoid destroying.

The secondary objective of this invention is to provide the thermally suppressing circuit, suitable to an auto-restart function of a restart-discharging drive IC, adapted to reduce a discharging time of a restart-discharging capacitor by means of detecting an auto-restart signal from the restart-discharging drive IC so that the design of the drive circuitry is improved.

The present invention is a thermally suppressing circuit for restarting a locked motor. The thermally suppressing circuit mainly comprises a restart-discharging drive member, a coil set, a restart-discharging capacitor, and a discharging switch set. The restart-discharging drive member is electrically connected to the coil set and the restart-discharging capacitor while the discharging switch set connected between the coil set and the restart-discharging capacitor. The discharging switch set is used to access signals output from the restart-discharging drive member. In abnormal operation, as the restart-discharging drive member may turn on an auto-restart function to output a high or low

voltage signal, the discharging switch set is turned on to accelerate discharging the restart-discharging capacitor to thereby avoid overcurrent passing the coil set.

Another aspect of the present invention is the discharging switch set comprised of a pair of diodes or a transistor and a pair of capacitor.

Another aspect of the present invention is a resistor in series connection between the discharging switch set and the restart-discharging capacitor. The resistance value is adapted to adjust the acceleration rate of the restart-discharging capacitor.

Other objectives, advantages and novel features of the invention will become more apparent from the following detailed description and the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will now be described in detail with reference to the accompanying drawings herein:

FIG. 1 is a circuitry of a conventional double phase brushless dc motor circuit in accordance with the prior art;

FIG. 2 is a circuitry of a conventional single-phase brushless dc motor circuit in accordance with the prior art;

FIG. 3 is a circuitry of a conventional double phase brushless dc motor circuit in accordance with the prior art;

FIG. 4A is a waveform diagram of a restart-discharging drive member and a restart-discharging capacitor of a brushless dc motor in accordance with the prior art;

FIG. 4B is a waveform diagram of a restart-discharging drive member and a restart-discharging capacitor of a brushless dc motor in accordance with the prior art;

FIG. 5 is a circuitry of a thermally suppressing circuit for a double phase brushless dc motor circuit in accordance with a first embodiment of the present invention;

FIG. 6 is a circuitry of a thermally suppressing circuit for a single-phase brushless dc motor circuit in accordance with a second embodiment of the present invention;

FIG. 7 is a circuitry of a thermally suppressing circuit for a double phase brushless dc motor circuit in accordance with a third embodiment of the present invention; and

FIG. 8 is a circuitry of a thermally suppressing circuit for a single-phase brushless dc motor circuit in accordance with a fourth embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 5 through, reference numerals of first through fourth embodiments have applied the identical numerals of the first conventional elements. The restart-discharging drive member and the restart-discharging capacity of these embodiments have the similar configuration and same function as the conventional elements.

Construction of the thermally suppressing circuit shall be described in detail, referring now to FIG. 5. The motor drive circuit 1 having a thermally suppressing circuit in accordance with a first embodiment of the present invention includes a restart-discharging drive member 10, a coil set (double coil) 11, two transistors 12, a restart-discharging capacitor 13, and a discharging switch set 14. The discharging switch set 14 is comprised of a transistor 141 and a pair of capacitors 142. The restart-discharging drive member 10 is electrically connected to the coil set 11 and the restart-discharging capacitor 13 while the discharging switch set 14 connected between the coil set 11 and the restart-discharging capacitor 13. The discharging switch set 14 is used to access

signals output from the restart-discharging drive member 10. In normal operation, the restart-discharging drive member 10 is adapted to control the coil set 11 by means of turning on or off. In abnormal operation, as the restart-discharging drive member 10 may turn on an auto-restart function to output a high or low voltage signal, the discharging switch set 14 is turned on to accelerate discharging the restart-discharging capacitor 13 to thereby avoid overcurrent passing the coil set 11. Consequently, the total discharging time of the restart-discharging capacitor 13 is reduced to avoid destroying the coil set 11. Meanwhile, a resistor 15 is connected in series between the restart-discharging capacitor 13 and the discharging switch set 14. The resistance value is adapted to adjust the acceleration rate of the restart-discharging capacitor 13.

Referring to FIGS. 4A and 5, as the restart-discharging drive member 10 turns on its auto-restart function to output a high voltage signal (Hi) within a time interval T2 and then the restart-discharging capacitor 13 is discharged to the ground. In this manner, the base of the transistor 141 of the discharging switch set 14 is alternatively turned on to allow passage of a current from the coil set 11 to thereby reduce the time interval T2. Subsequently, once the restart-discharging drive member 10 outputs a low voltage signal (Lo) within a time interval T1, the discharging operation of the discharging capacitor 13 is terminated. Then, the discharging switch set 14 is turned off and the restart-discharging capacitor 13 is actuated to be charged.

Referring again to FIGS. 4A and 5, the restart-discharging drive member 10 repeatedly restarts the motor at each time interval T2 until the abnormal operation is eliminated. Since the discharging time of the time interval T2 is shortened in abnormal operation, the motor can avoid passing an overcurrent which is capable destroying it. In design the adjustment of the time interval T2 is chosen depending upon motor's features.

Referring to FIG. 6, the motor drive circuit 2 having a thermally suppressing circuit in accordance with a second embodiment of the present invention includes a restart-discharging drive member 20, a coil set (single coil) 21, a restart-discharging capacitor 22, and a discharging switch set 23. The discharging switch set 23 is comprised of a transistor 231 and a pair of capacitors 232. The restart-discharging drive member 20 is electrically connected to the coil set 21 and the restart-discharging capacitor 22 while the discharging switch set 23 connected between the coil set 21 and the restart-discharging capacitor 22. The discharging switch set 23 is used to access signals output from the restart-discharging drive member 20. In normal operation, the restart-discharging drive member 20 is adapted to control the coil set 21 by means of turning on or off. In abnormal operation, as the restart-discharging drive member 20 may turn on an auto-restart function to output a high or low voltage signal, the discharging switch set 23 is turned on to accelerate discharging the restart-discharging capacitor 22 to thereby avoid overcurrent passing the coil set 21. Consequently, the total discharging time of the restart-discharging capacitor 22 is reduced to avoid destroying the coil set 21. Meanwhile, a resistor 24 is connected in series between the restart-discharging capacitor 22 and the discharging switch set 23. The resistance value is adapted to adjust the acceleration rate of the restart-discharging capacitor 22.

Referring to FIGS. 4A and 6, as the restart-discharging drive member 20 turns on its auto-restart function to output a high voltage signal (Hi) within a time interval T2, the restart-discharging capacitor 22 is discharged to the ground.

5

In this manner, the base of the transistor **231** of the discharging switch set **23** is alternatively turned on the capacitor **C1** or **C2** to allow passage of a current from the coil set **21** to thereby reduce the time interval **T2**. Subsequently, once the restart-discharging drive member **20** outputs a low voltage signal (Lo) within a time interval **T1**, the discharging operation of the discharging capacitor **22** is terminated. Then, the discharging switch set **23** is turned off and the restart-discharging capacitor **22** is actuated to be charged.

Referring to FIG. 7, the motor drive circuit **2** having a thermally suppressing circuit in accordance with a third embodiment of the present invention includes a restart-discharging drive member **20**, a coil set (single coil) **21**, a restart-discharging capacitor **22**, and a discharging switch set **23**. The discharging switch set **23** is comprised of a pair of diodes **D1** and **D2**. The restart-discharging drive member **20** is electrically connected to the coil set **21** and the restart-discharging capacitor **22** while the discharging switch set **23** connected between the coil set **21** and the restart-discharging capacitor **22**. The discharging switch set **23** is used to access signals output from the restart-discharging drive member **20**. In normal operation, the restart-discharging drive member **20** is adapted to control the coil set **21** by means of turning on or off. In abnormal operation, as the restart-discharging drive member **20** may turn on an auto-restart function to output a high or low voltage signal, the discharging switch set **23** is turned on to accelerate discharging the restart-discharging capacitor **22** to thereby avoid overcurrent passing the coil set **21**. Consequently, the total discharging time of the restart-discharging capacitor **22** is reduced to avoid destroying the coil set **21**. Meanwhile, a resistor **24** is connected in series between the restart-discharging capacitor **22** and the discharging switch set **23**. The resistance value is adapted to adjust the acceleration rate of the restart-discharging capacitor **22**.

Referring to FIGS. 4B and 7, as the restart-discharging drive member **20** turns on its auto-restart function to output a low voltage signal (Lo) within a time interval **T2**, the restart-discharging capacitor **22** is discharged to the ground. In this manner, the diodes **D1** or **D2** of the discharging switch set **23** alternatively turns on to allow passage of a current from the coil set **21** to thereby reduce the time interval **T2**. Subsequently, once the restart-discharging drive member **20** outputs a high voltage signal (Hi) within a time interval **T1**, the discharging operation of the discharging capacitor **22** is terminated. Then, the discharging switch set **23** is turned off and the restart-discharging capacitor **22** is actuated to be charged.

Referring to FIG. 8, the motor drive circuit **3** having a thermally suppressing circuit in accordance with a fourth embodiment of the present invention includes a restart-discharging drive member **30**, a coil set (double coil) **31**, a restart-discharging capacitor **32**, and a discharging switch set **33**. The discharging switch set **33** is comprised of a transistor **331** and a pair of capacitors **332**. The restart-discharging drive member **30** is electrically connected to the coil set **31** and the restart-discharging capacitor **32** while the discharging switch set **33** connected between the coil set **31** and the restart-discharging capacitor **32**. The discharging switch set **33** is used to access signals output from the restart-discharging drive member **30**. In normal operation, the restart-discharging drive member **30** is adapted to control the coil set **31** by means of turning on or off. In abnormal operation, as the restart-discharging drive member **30** may turn on an auto-restart function to output a high or low voltage signal, the discharging switch set **33** is turned on to

6

accelerate discharging the restart-discharging capacitor **32** to thereby avoid overcurrent passing the coil set **31**. Consequently, the total discharging time of the restart-discharging capacitor **32** is reduced to avoid destroying the coil set **21**. Meanwhile, a resistor **34** is connected in series between the restart-discharging capacitor **32** and the discharging switch set **33**. The resistance value is adapted to adjust the acceleration rate of the restart-discharging capacitor **32**.

Referring to FIGS. 4B and 8, as the restart-discharging drive member **30** turns on its auto-restart function to output a low voltage signal (Lo) within a time interval **T2**, the restart-discharging capacitor **32** is discharged to the ground. In this manner, the base of the transistor **331** of the discharging switch set **23** alternatively turns on the capacitor **C1** or **C2** to allow passage of a current from the coil set **31** to thereby reduce the time interval **T2**. Subsequently, once the restart-discharging drive member **30** outputs a high voltage signal (Hi) within a time interval **T2**, the discharging operation of the discharging capacitor **32** is terminated. Then, the discharging switch set **33** is turned off and the restart-discharging capacitor **32** is actuated to be charged.

Although the invention has been described in detail with reference to its presently preferred embodiment, it will be understood by one of ordinary skill in the art that various modifications can be made without departing from the spirit and the scope of the invention, as set forth in the appended claims.

What is claimed is:

1. A thermally suppressing circuit, comprising:

a restart-discharging drive member having an auto-restart function which is turned on during abnormal operation;
a coil set connected to the restart-discharging drive member which controls turn on or turn off of the coil set;
a discharging switch set connected to the coil set and adapted to access signals output from the restart-discharging drive member, said discharging switch set including a transistor and a pair of capacitors; and
a restart-discharging capacitor discharged to ground while the auto-restart function turns on;

wherein when the restart-discharging drive member turns on the auto-restart function, the discharging switch set is turned on to accelerate discharging the restart-discharging capacitor.

2. The thermally suppressing circuit as defined in claim 1, further comprising a resistor connected in series between the restart-discharging capacitor and the discharging switch set, the resistor being adapted to adjust an acceleration rate of the restart-discharging capacitor.

3. The thermally suppressing circuit as defined in claim 1, wherein the restart-discharging drive member turns on the auto-restart function to output a high voltage signal during abnormal operation, so that the discharging switch set is turned on to accelerate discharging the restart-discharging capacitor.

4. The thermally suppressing circuit as defined in claim 1, wherein the restart-discharging drive member turns on the auto-restart function to output a low voltage signal during abnormal operation, so that the discharging switch set is turned on to accelerate discharging the restart-discharging capacitor.

5. The thermally suppressing circuit as defined in claim 1, wherein the coil set is a double coil.

6. The thermally suppressing circuit as defined in claim 1, wherein the coil set is a single coil.